VLPC Detectors: Central Fiber Tracker & Pre-shower

Shift Tutorial

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Tracking Shifts: CFT & PS

- CFT & PS provide essential data for the D0 experiment
- CFT & PS collect data usually 7 days a week most of the year during **global, cosmic, and zero-bias runs**
- Tracking shifts are offset by 4 hours from other control room shifts:

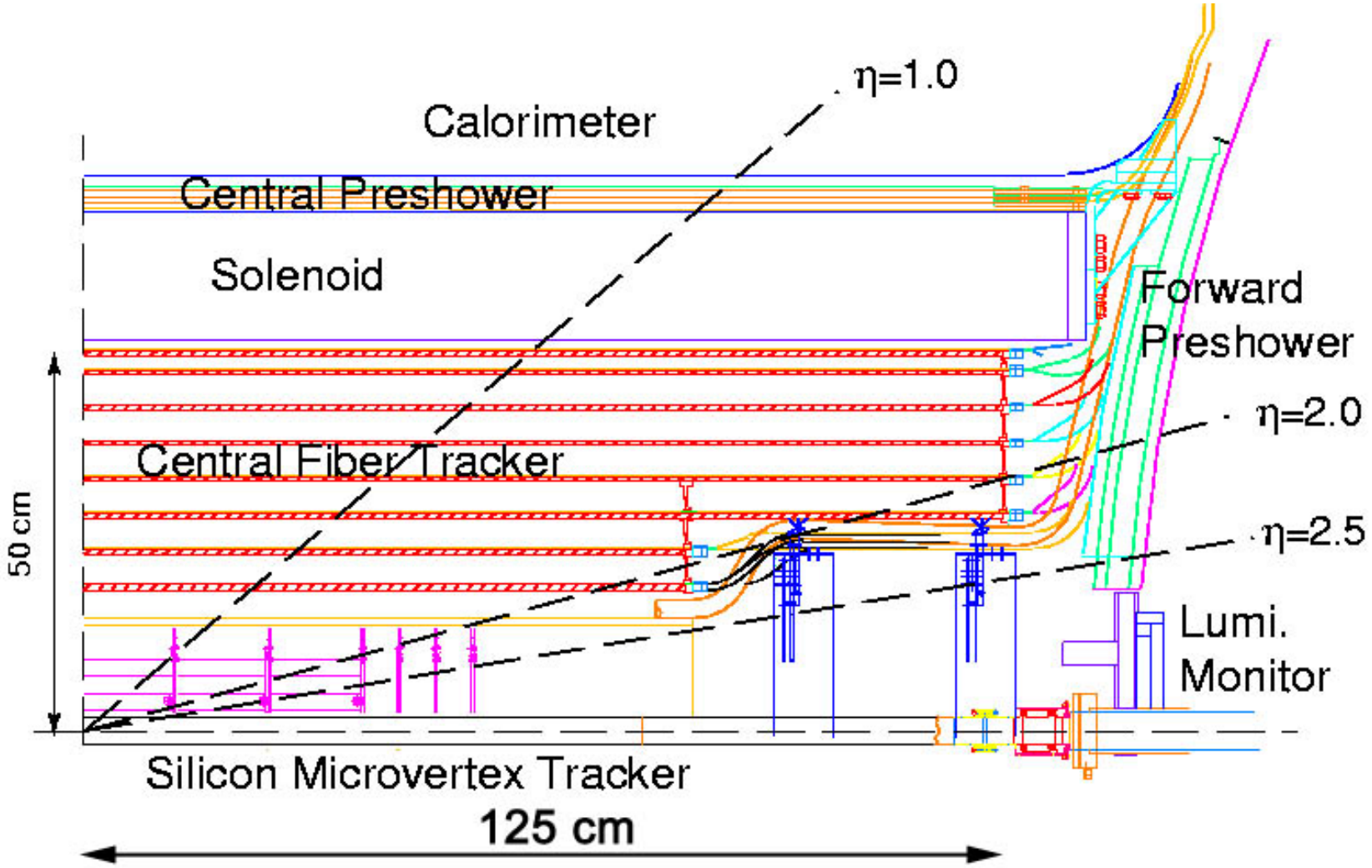
Farmer	4:00 am	–	12:00 pm
Country Club	12:00 pm	–	8:00 pm
Vampire	8:00 pm	–	4:00 am

- Shifter required to arrive on shift about 5-10 minutes prior to start of shift to discuss current system status with previous shifter
- Any shifter may request extra training shifts if they feel it is needed!

Purpose of Shifts

- **Monitor detector's readout and response**
  - Watch for alarms: Bias, temperature, power supplies, DAQ and others
  - Ensure data quality
- **Minimize down time**
  - Fix most problems
  - Page experts when necessary
- Assist experts in taking calibration runs, performing maintenance
- **Understand the detector and optimize it's performance**
- **Feedback on tools needed for shifts**
- Accomplish any extra stated shift goals

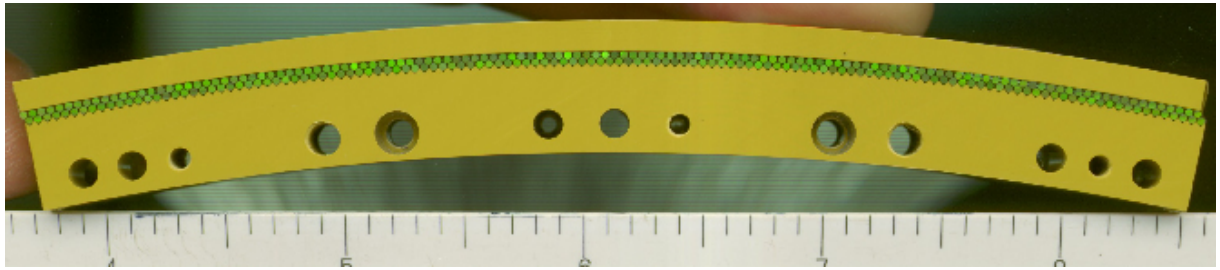
Central Fiber Tracker and Preshower Overview

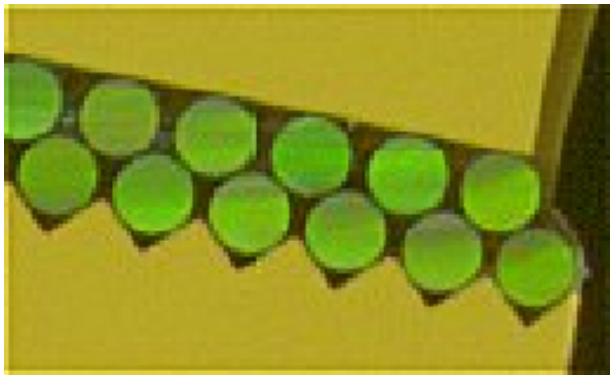


- Actually, 3 detectors:
  - **CFT:** 8 barrels = 8 axial + 8 stereo doublet layers ≈ 77,000 channels
  - **CPS:** 1 axial + 2 stereo (U, V) stereo layers ≈ 7,000 channels
  - **FPS:** 2 MIP + 2 shower layers ≈ 15,000 channels
- CFT and PS utilize similar readout through Visible Light Photon Counters (VLPCs)

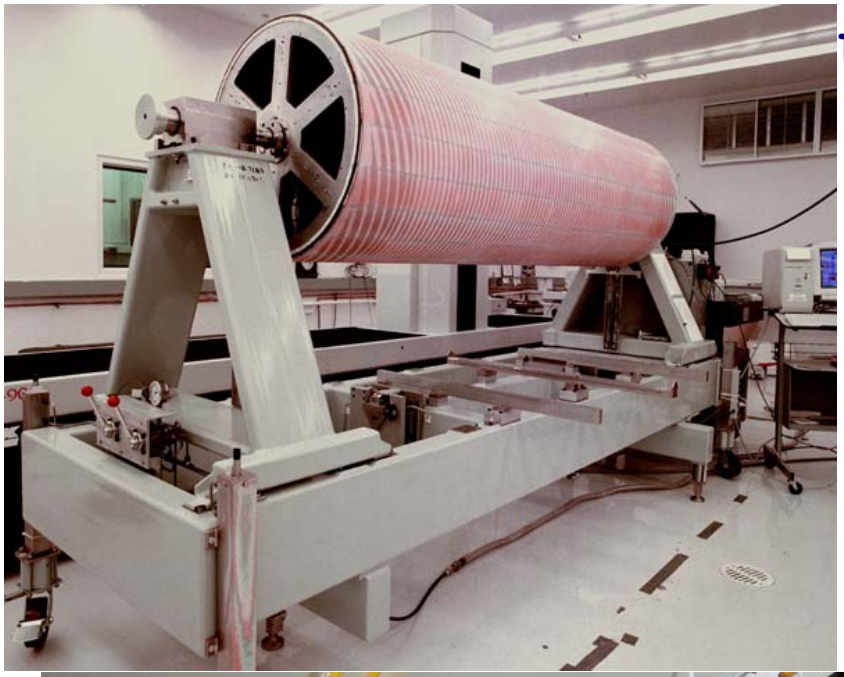
The CFT: Essential Details

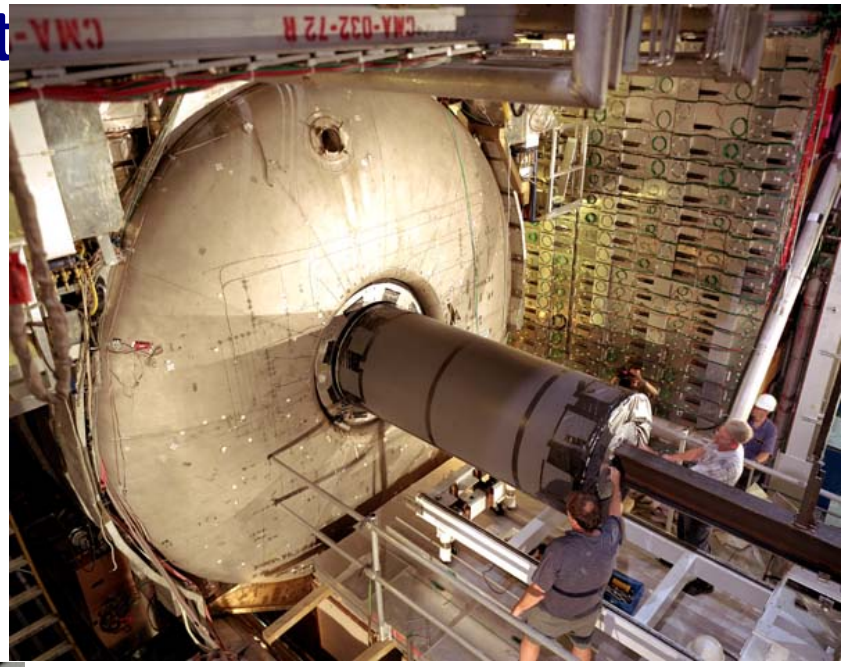
- CFT scintillating fibers arranged into precisely positioned ribbons of interlocked fiber doublets

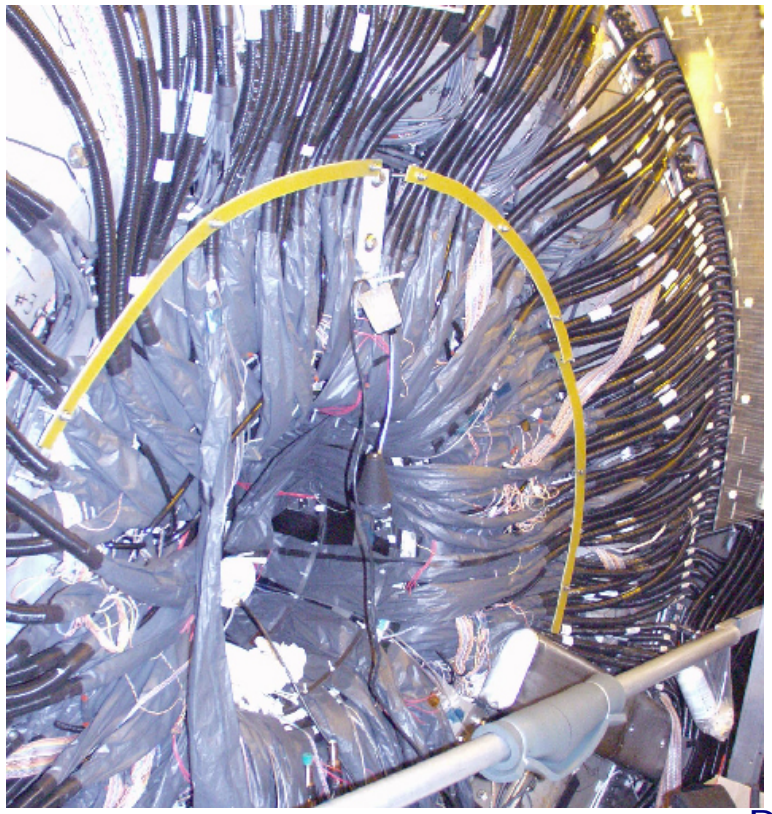




- Fibers are mounted on outside surface of eight carbon fiber support cylinders
- Axial layers are formed by fibers oriented along the cylinder axis
- Stereo layers are formed by fibers oriented at $\pm 3^{\circ}$ angle
- position resolution of fiber doublet is $approx$ 100 μm

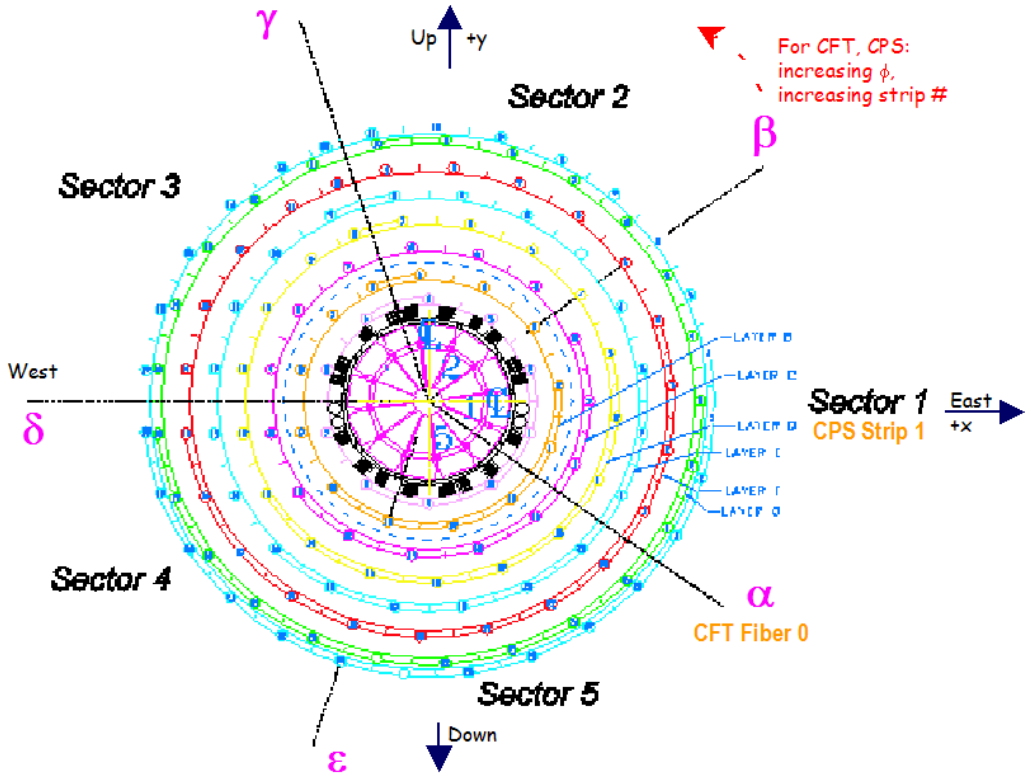


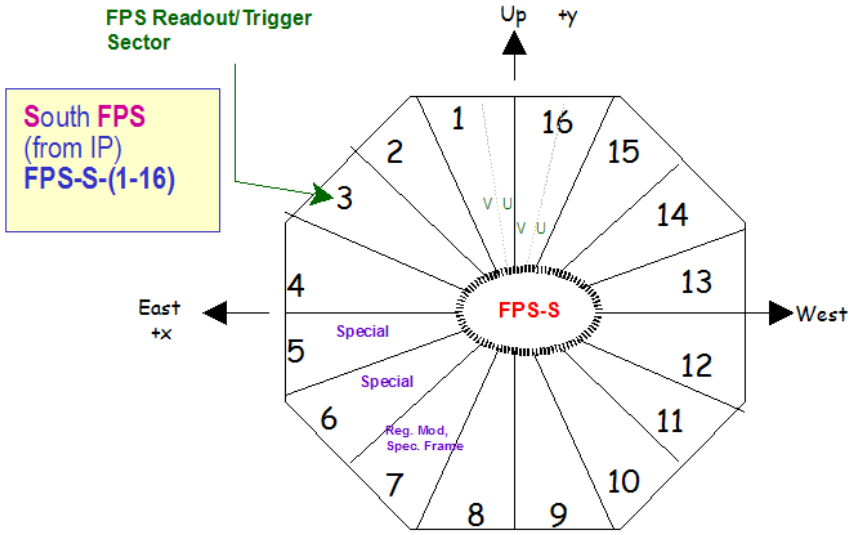


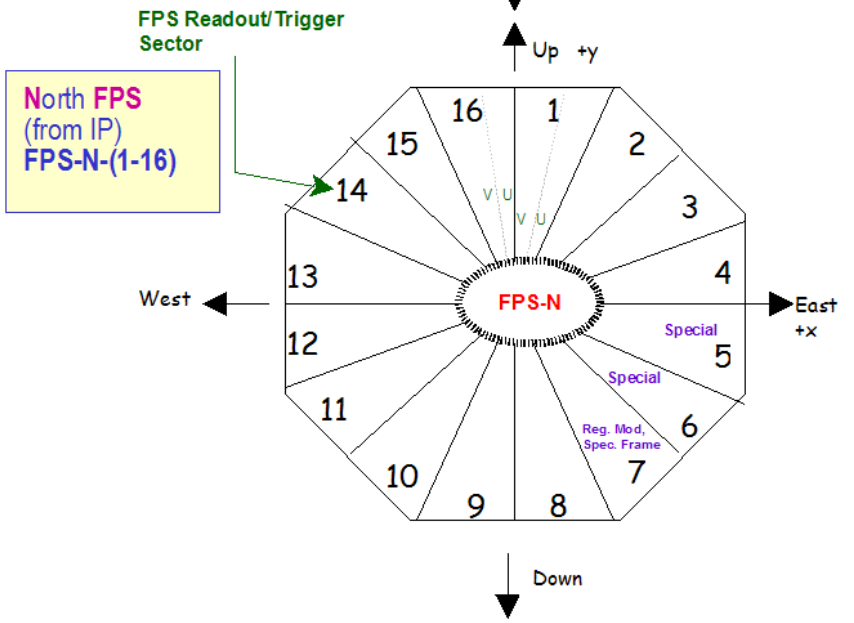


CFT & PS Coverage and Geometry

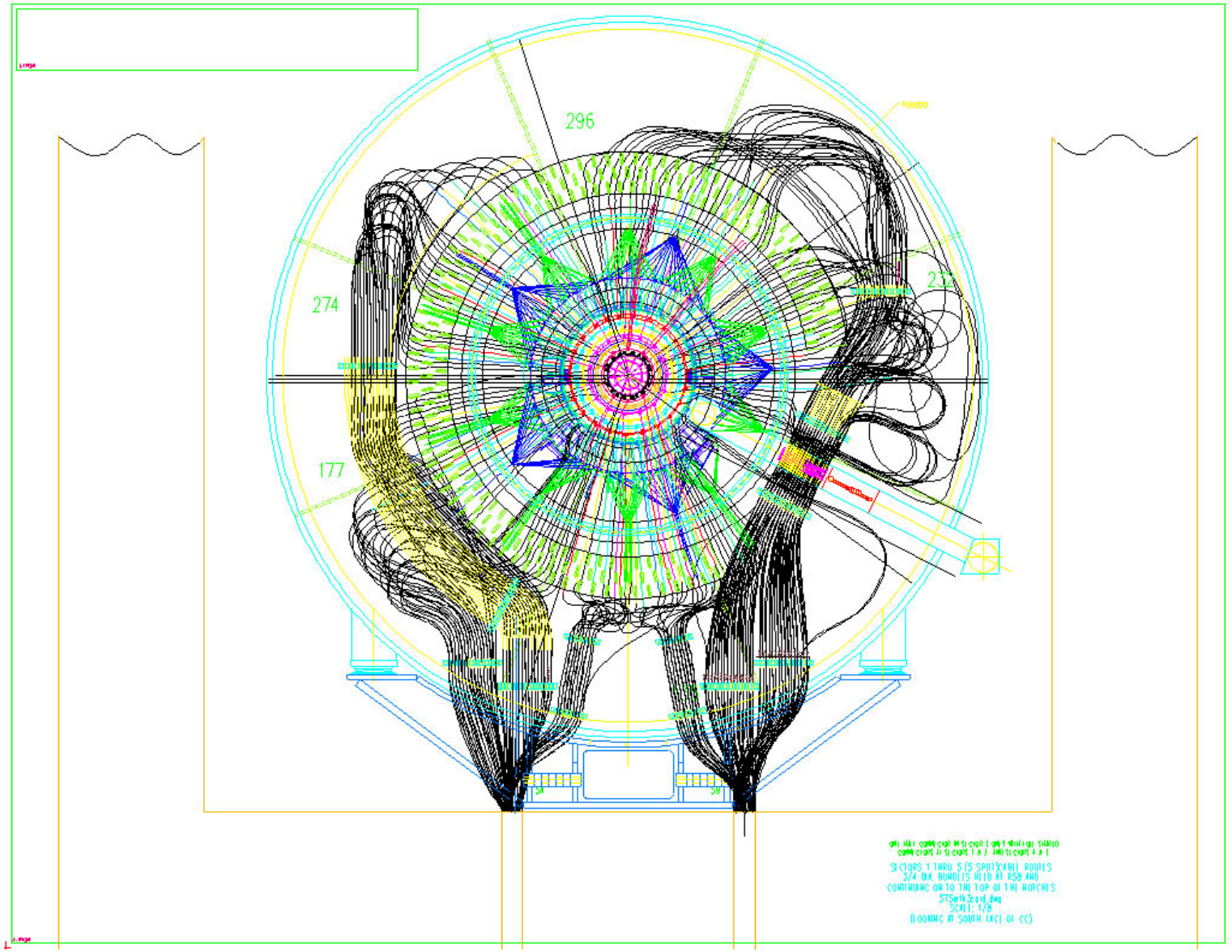
- Scintillating fibers are 1.8 or 2.6 m long
- Waveguides length varies from 8.2 to 11.4 m
- CFT fiber diameter is 835 μm
- 5 "Super Sectors" in ϕ for the CFT and CPS
- 80 individual sectors in all. Normal CTT examine readout mode.



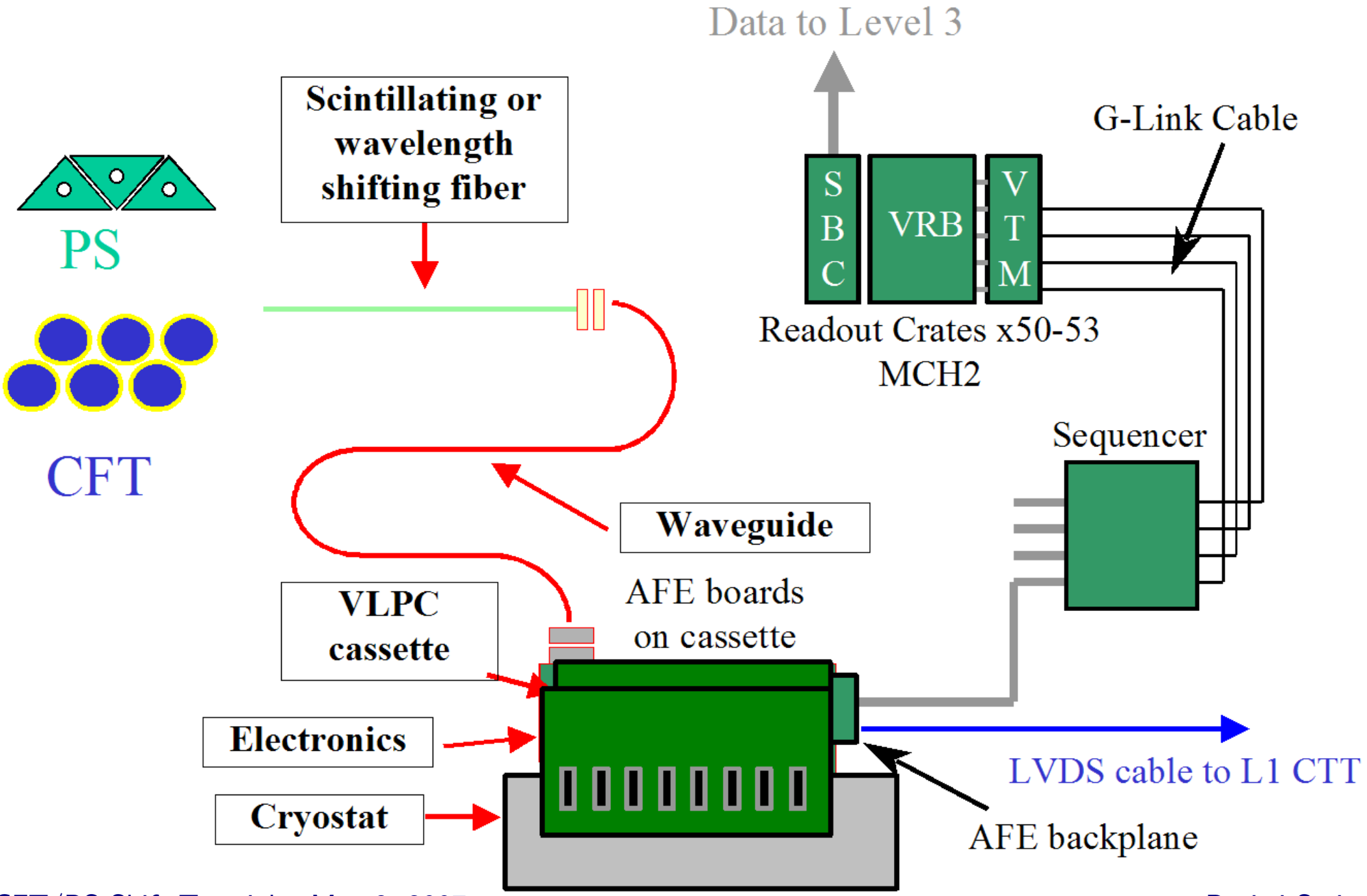




The Waveguides

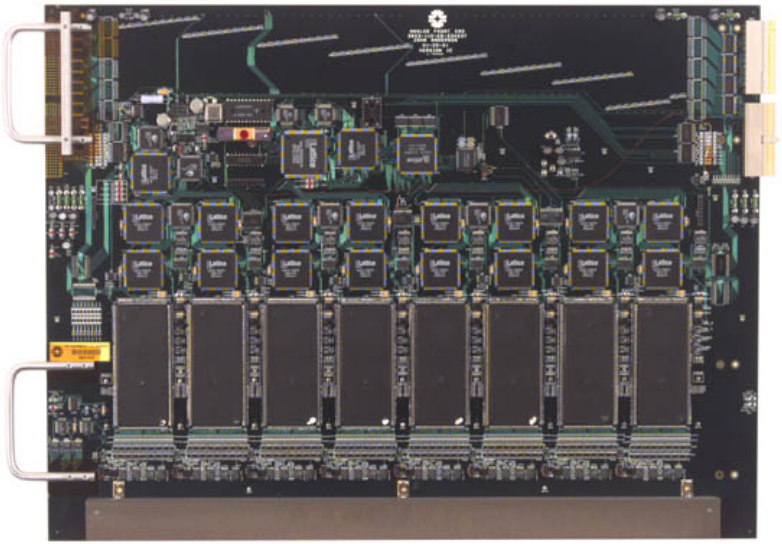


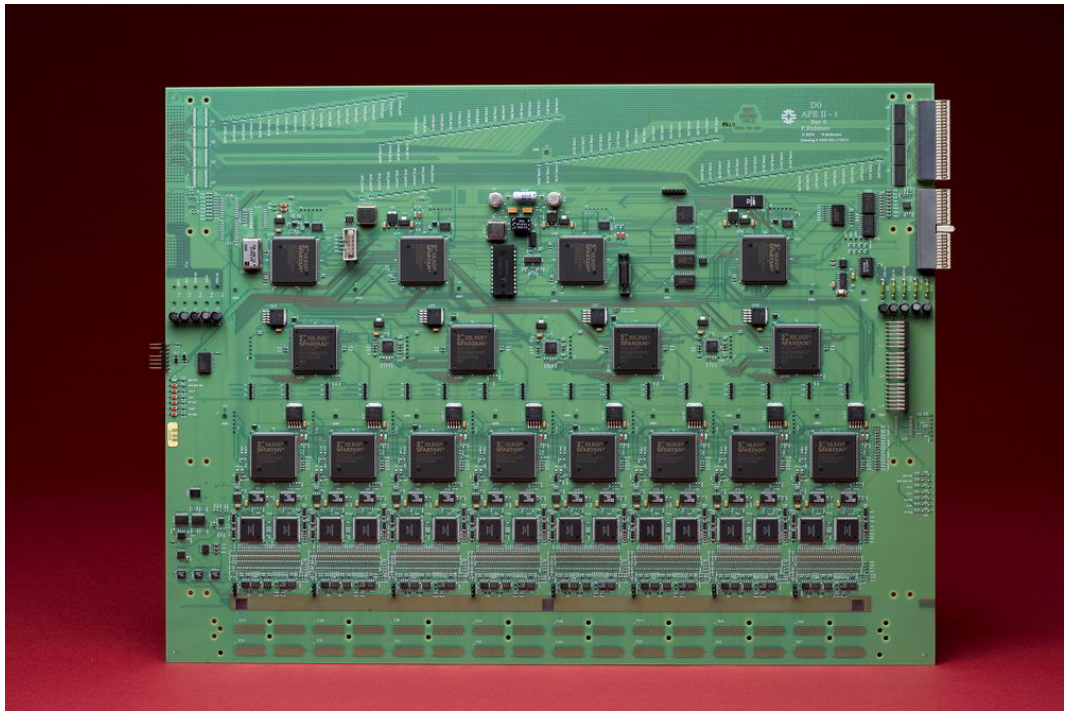
CFT & PS Readout



Analog Front-End (AFE) Boards

- AFEI (left) and AFEII-t (right) shown below



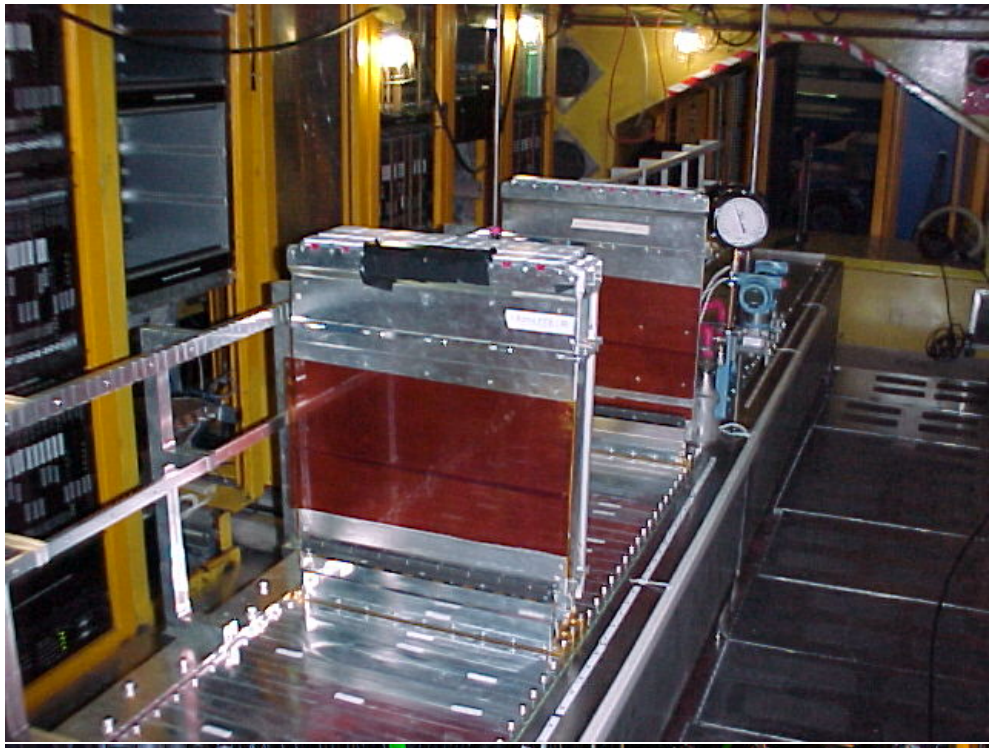


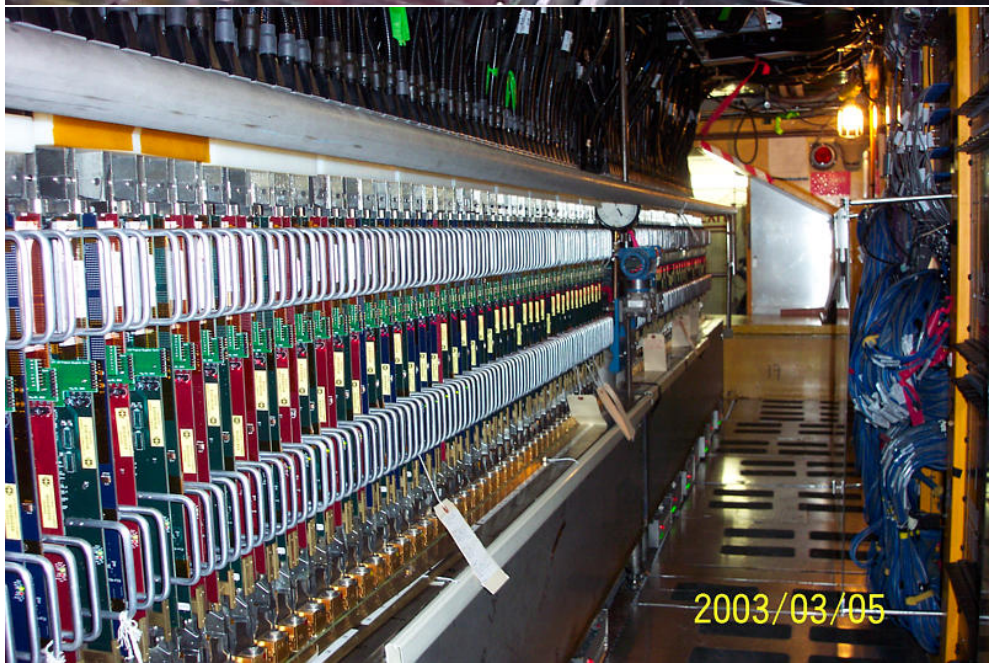
- One board can readout up to 512 channels
- Two kinds of boards: Left-hand and right-hand
- AFE forms discriminated output for trigger and controls VLPC bias voltage
- Only right-hand boards control the temperature of the VLPCs.
  Boards installed in pairs in the cryo cassettes

VLPC Cassette

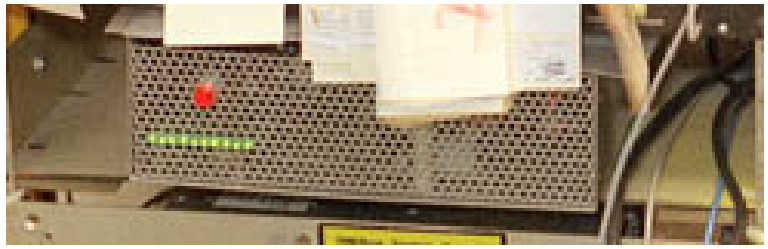
- Cassettes provide mechanical support, optical alignment, and appropriate operating services for proper operation and readout of the VLPCs
- Lower portion immersed in gas Helium
- Upper portion supports a pair of AFE boards
- A mock setup with one cryo cassette is available in DAB3's visitor area. Look on your own or ask an expert for a tour!

Cryostat & AFE Cassets Pictures





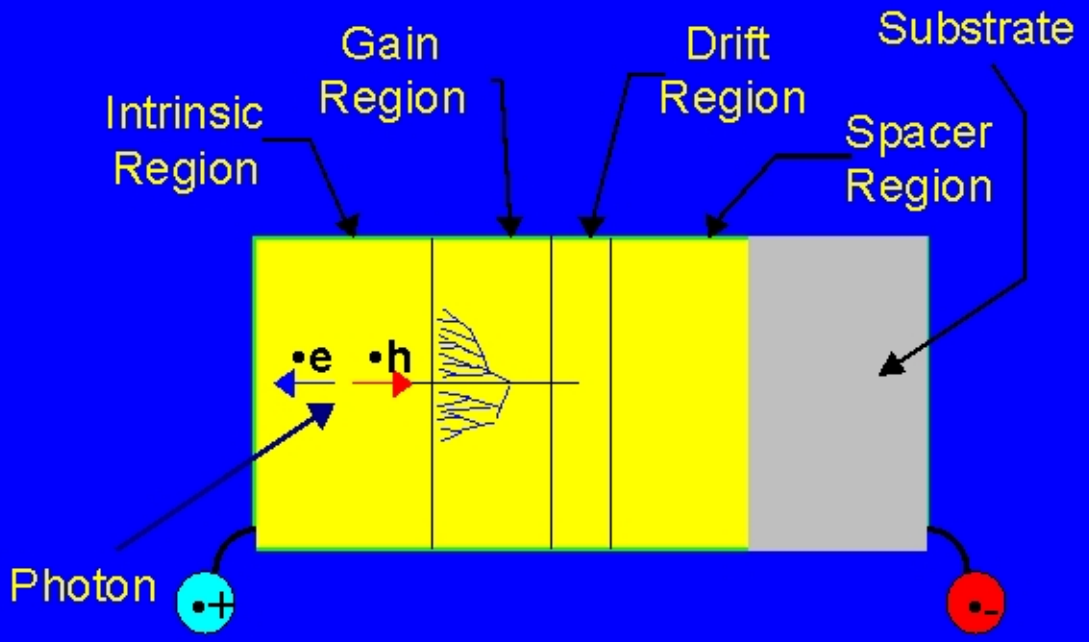
AFE Power Supplies

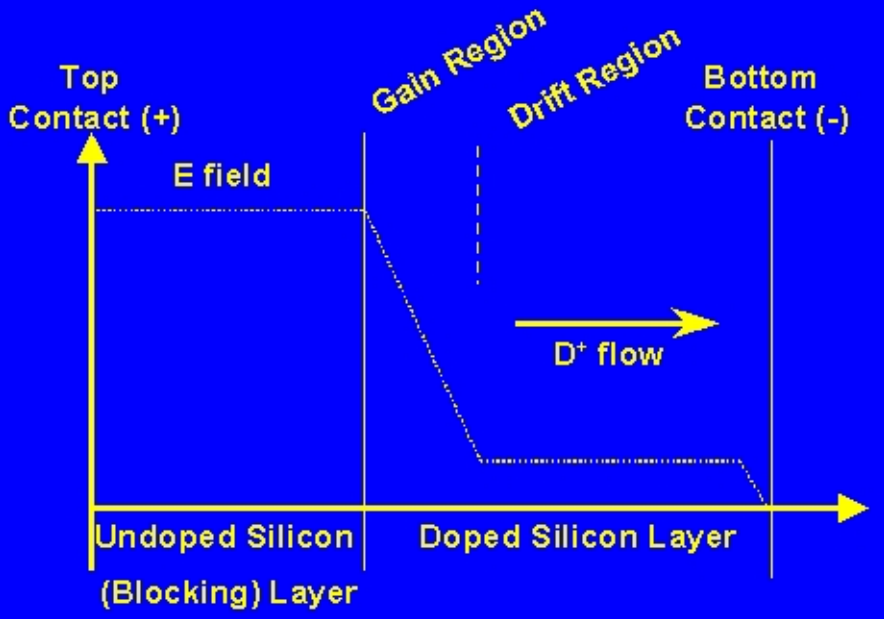


- The AFE boards are powered by thirteen Vicor power supplies under the cryostat
- Each Vicor powers one 'AFE Crate' which contains up to sixteen AFE boards
- The thirteen AFE crates are each divided into A and B halves that can be powered up and down
- These crates also give the AFEs their operational names like '4B0'
  4B is the half crate and there are 8 boards, 0-7. Even numbered boards are left-hand
- The PS provides $+12$, $+5.5$, $+5$, $+3.3$, and -12
- They can be powered remotely from the control room or the platform itself

VLPC Operational Principles

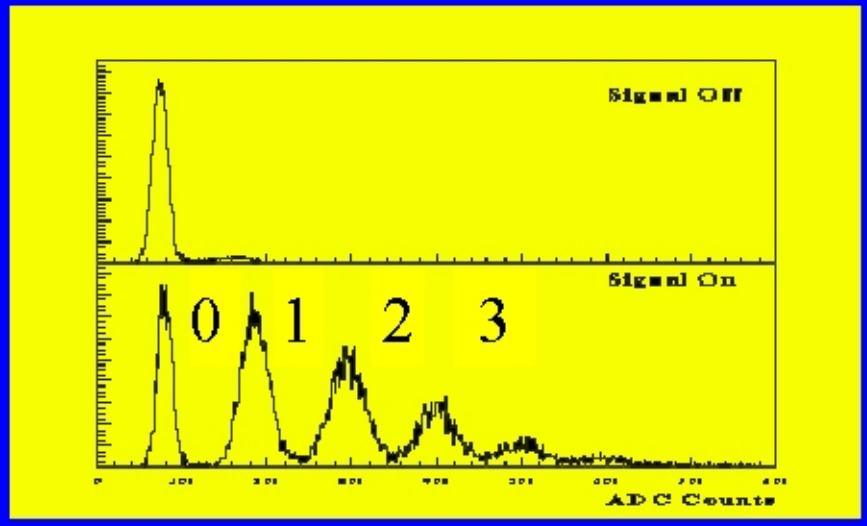
- Photon is converted in the intrinsic region, creating an electron-hole pair.
- Hole drifts into the drift region, where it knocks an electron out from an atom.
- Electron accelerates back through gain region, knocking electrons from atoms as it goes.
- Spacer region and substrate are for mechanical support and field shaping.
- Thus each photon generates a pulse of many electrons. Gains of ×20,000 – 60,000 are achievable.

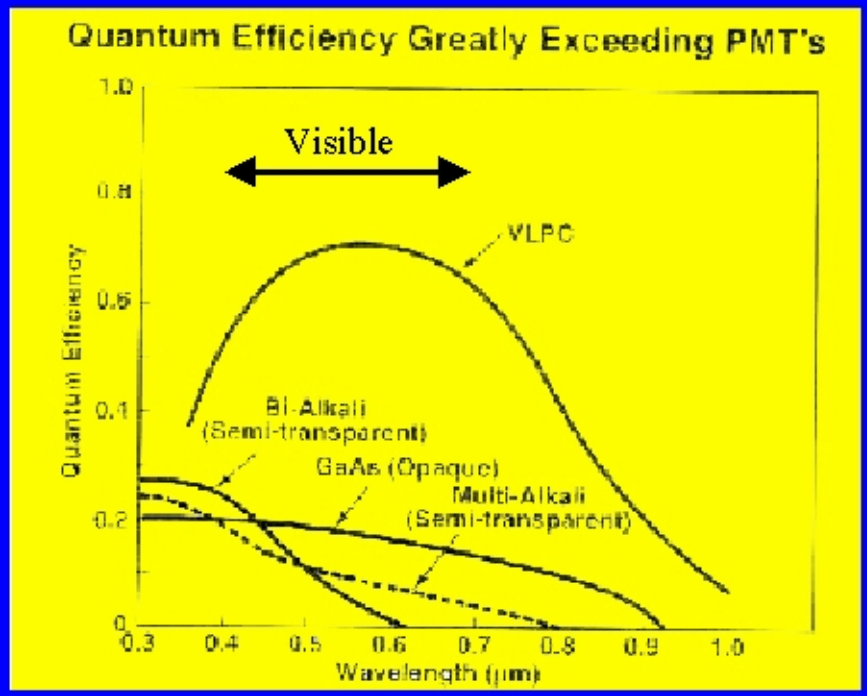




HiSTE VI

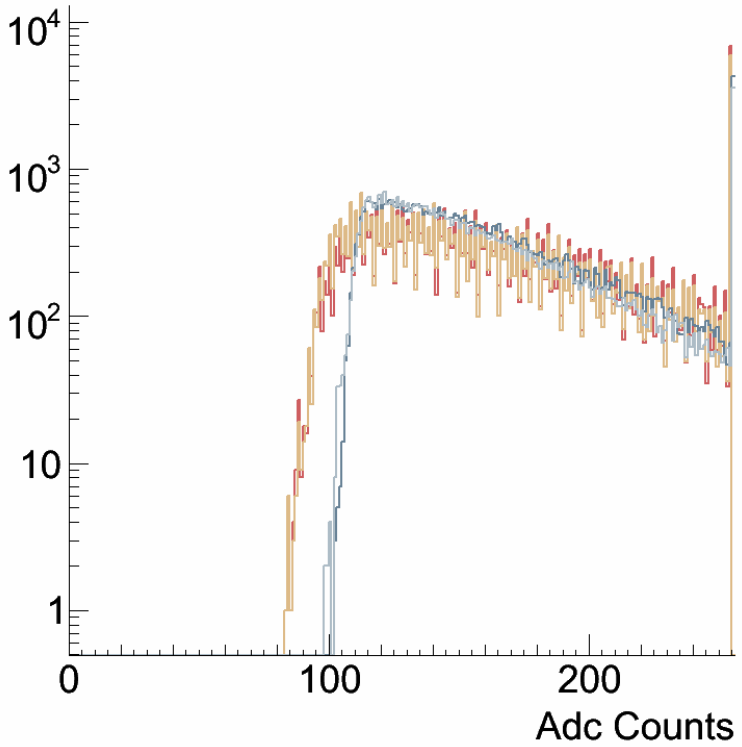
- Solid state photon detectors
- Operate at a few degrees Kelvin (~ -450° F)
- Bias voltage 6-8 Volts
- Detects single photons
- Can work in a high rate environment
- Quantum efficiency for visible light ~80%
- High gain ~50 000 electrons per converted photon
- Low gain dispersion
- Highly suppressed infrared sensitivity

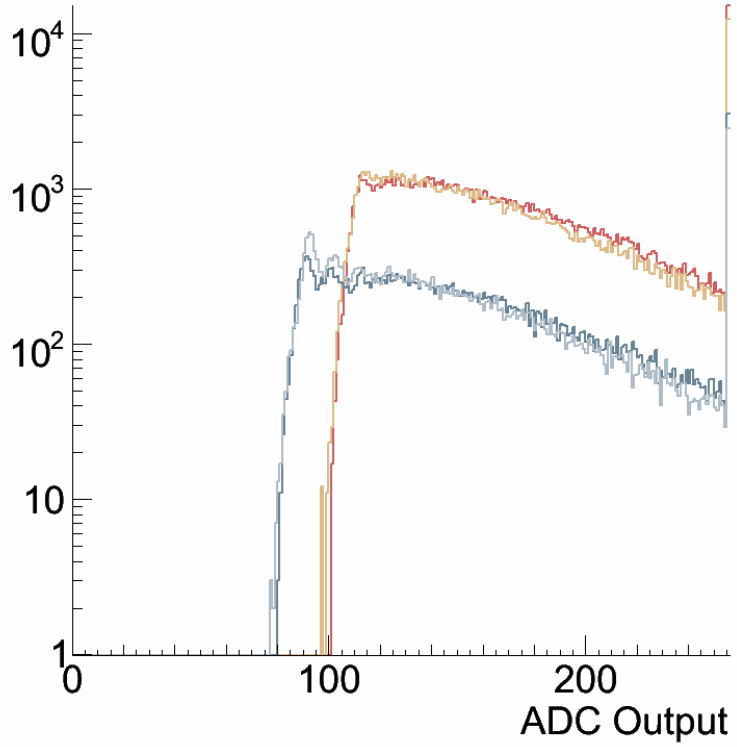




AFE Boards Upgrade: AFEII-t

- Each AFE board reads out 512 channels
- All but FPS AFEI boards were replaced with AFEII-t
- Totally redesigned AFEII increases signal efficiency

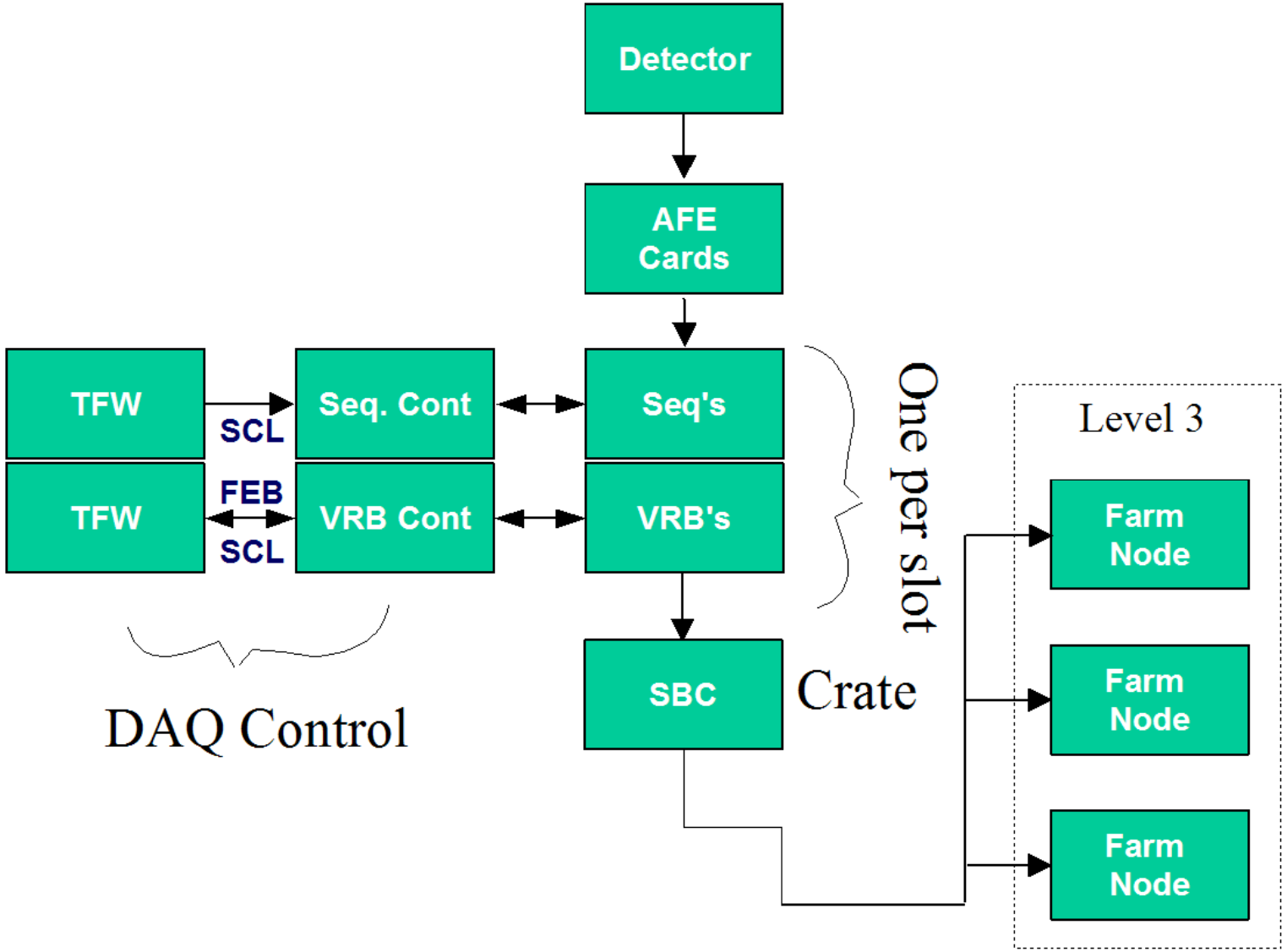




- AFEIIs are more stable, therefore, need less frequent calibrations
- AFEIIs are capable of producing the time signal

Primary DAQ Data Flow

- AFE boards controlled by SEQuencers and data is readout to VRBs



- AFE boards, sequencers, and seq. controllers located on the platform
- VRBs, VRBCs, and SBCs located in VRB crates 0x50–0x53 in MCH2

VME Readout Buffer (VRB) Crates

- There are four VRB crates in MCH2 that handle all of our data.

0x50	**CFTAX**	The entire CFT axial
0x51	**CFTST**	Mixed CFTS and CPS
0x52	**CPS**	Mixed CFTS and CPS
0x53	**FPS**	The complete FPS

- Each sequencer crate in the pit feeds two VRB crates upstairs
- Each sequencer sends its signals to a VTM which converts the light pulse to an electronic signal on the crate's backplane which is picked up by the corresponding VRB

Special Units in the VRB Crates

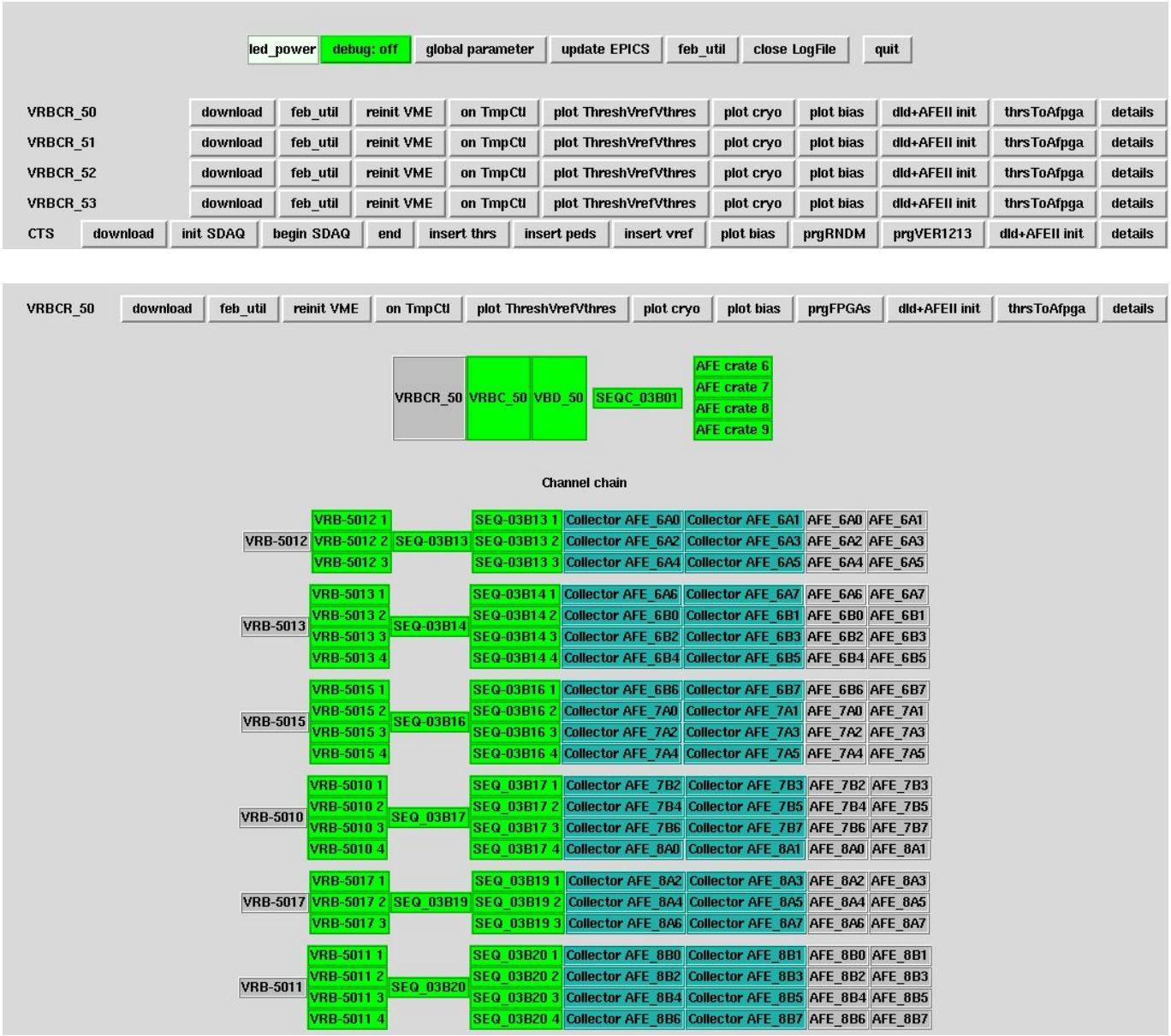
- Each VRB Crate contains three special units:
  - One VRB Controller (VRBC) that controls the crate
  - One Single Board Computer (SBC) that is our interface with the L3 trigger
  - One Power PC (IOC) that does some controlling of the crate and is the secondary data acquisition path

Shifter's Primary Tools

- **Online Monitoring Software: Examines**
  - FT Examine: CFT, CPS, FPS
  - PDAQ Examine
  - CTT Examine
- **CFT+PS/CTT specific**
  - CFT GUI
  - FEB_Util & Crate x13 VRB Monitor
  - Channel Archiver
  - CTT GUI & DFE Expert GUI
  - Other Specialized Software (e.g., AFE Monitor, A/O Term Grabber)
- **DAQ tools**
  - Taker SDAQ (mostly used by experts for calibration, and pedestal Runs)
  - Daq monitor
  - l3x_qt_display + DAQ_Dialog
  - Coormon
  - Electronic Logbook (e-log)
  - Significant Event Server (SES) Alarm System

CFT GUI

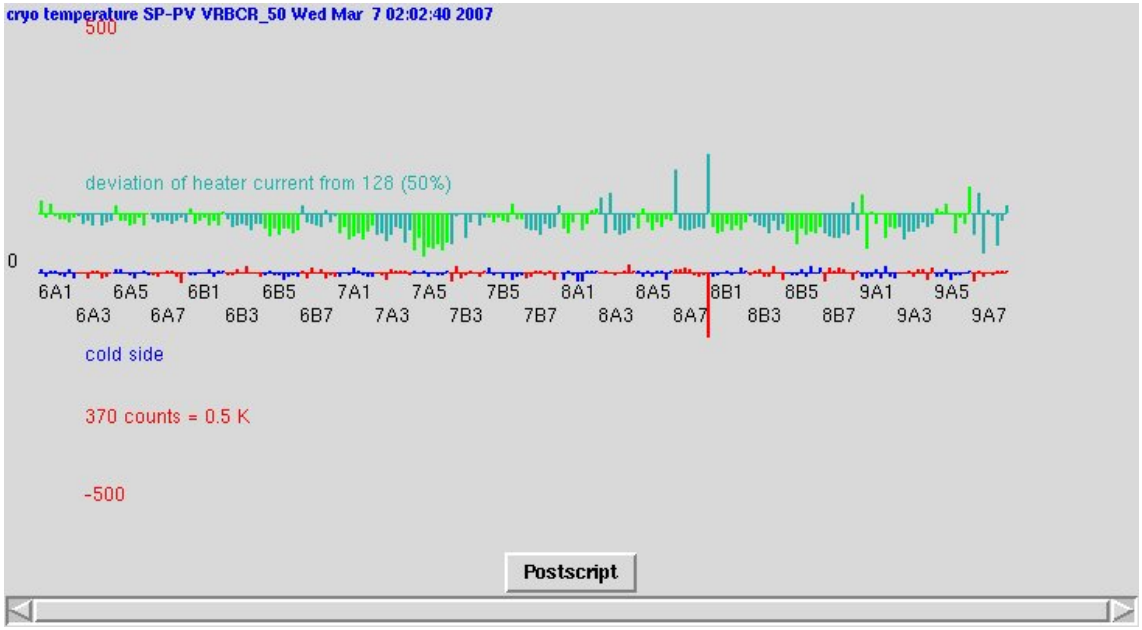
- The CFT GUI is used for downloading various parameters into the hardware
- Calibration runs are configured using the CFT GUI
- The CFT shifter can use it to diagnose and fix alarms



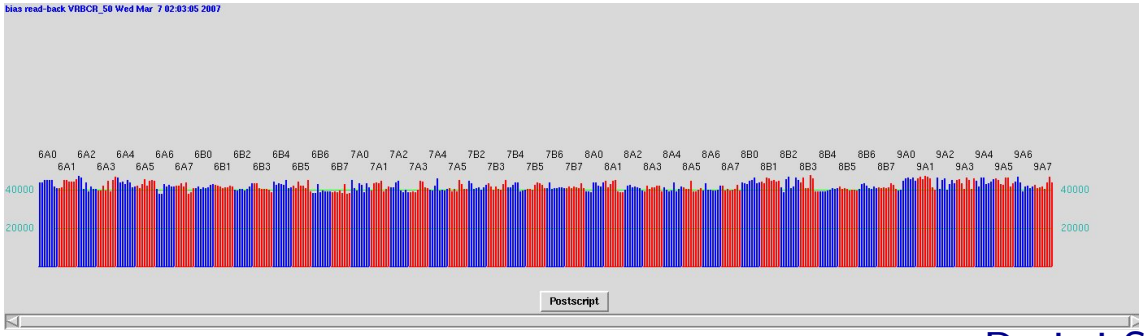
CFT GUI

- Some boards may be disabled. Disabled boards are shown in yellow

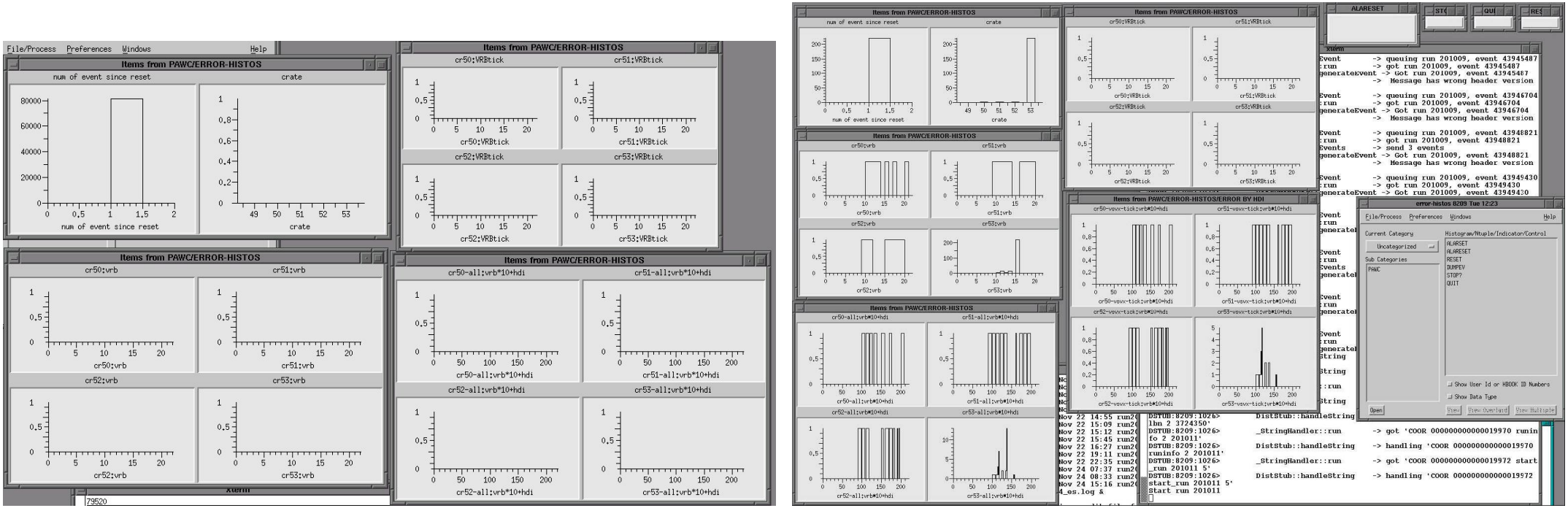
- 'plot cryo' button invokes a window with the temperature of VLPCs and the heater currents



- 'plot bias' button invokes a window with the bias voltages on the VLPCs

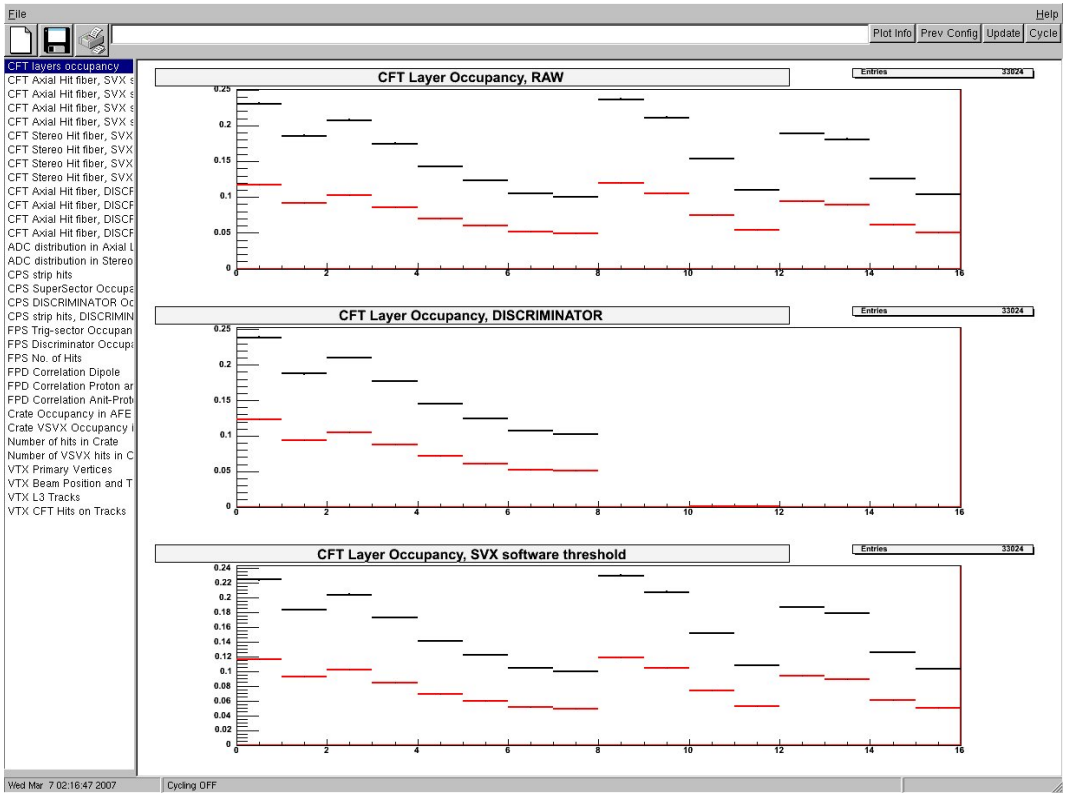


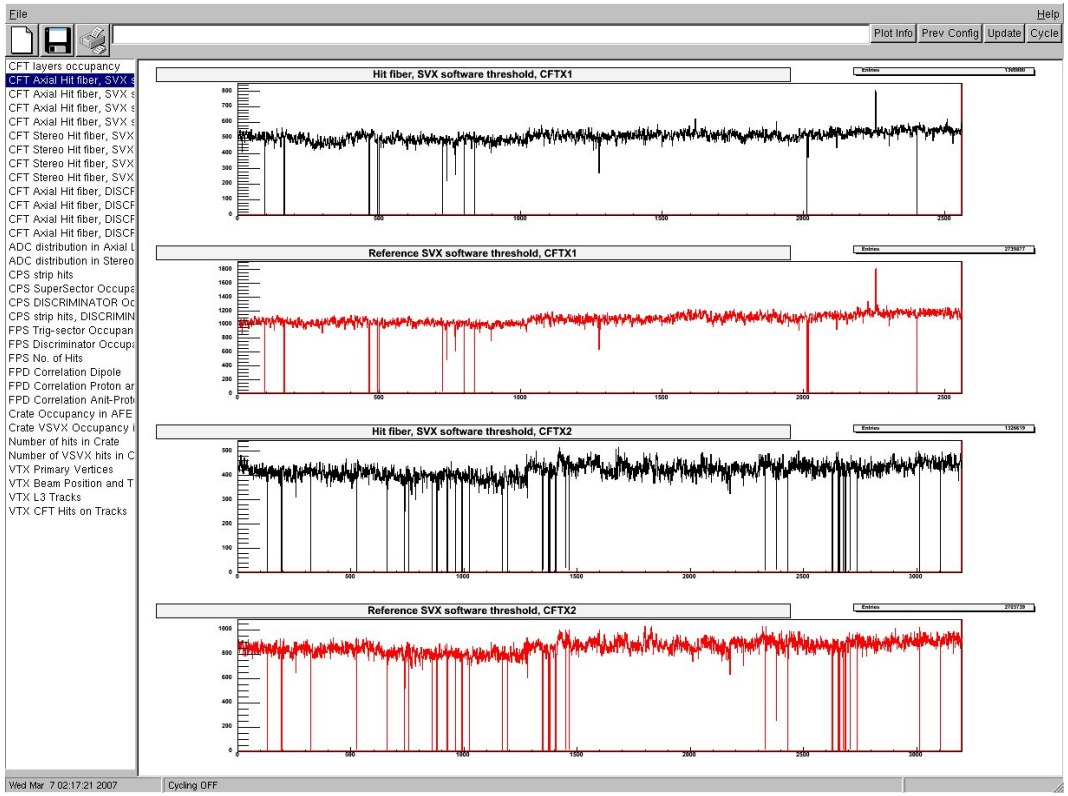
PDAQ Examine



- The PDAQ Examine tracks many kinds of errors that can occur in the data from our crates. Certain errors will cause alarms in the significant event system. Use the 'ALARESET' button to turn these alarms off once the problem has been addressed!

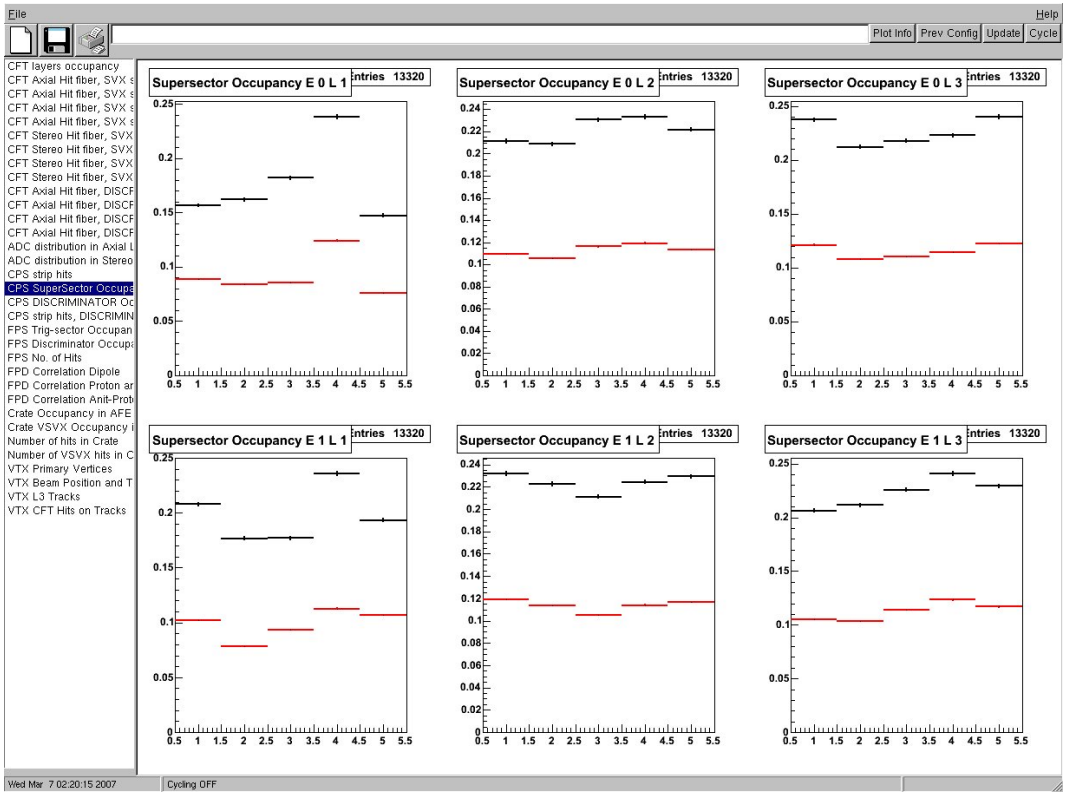
FT Examine: CFT

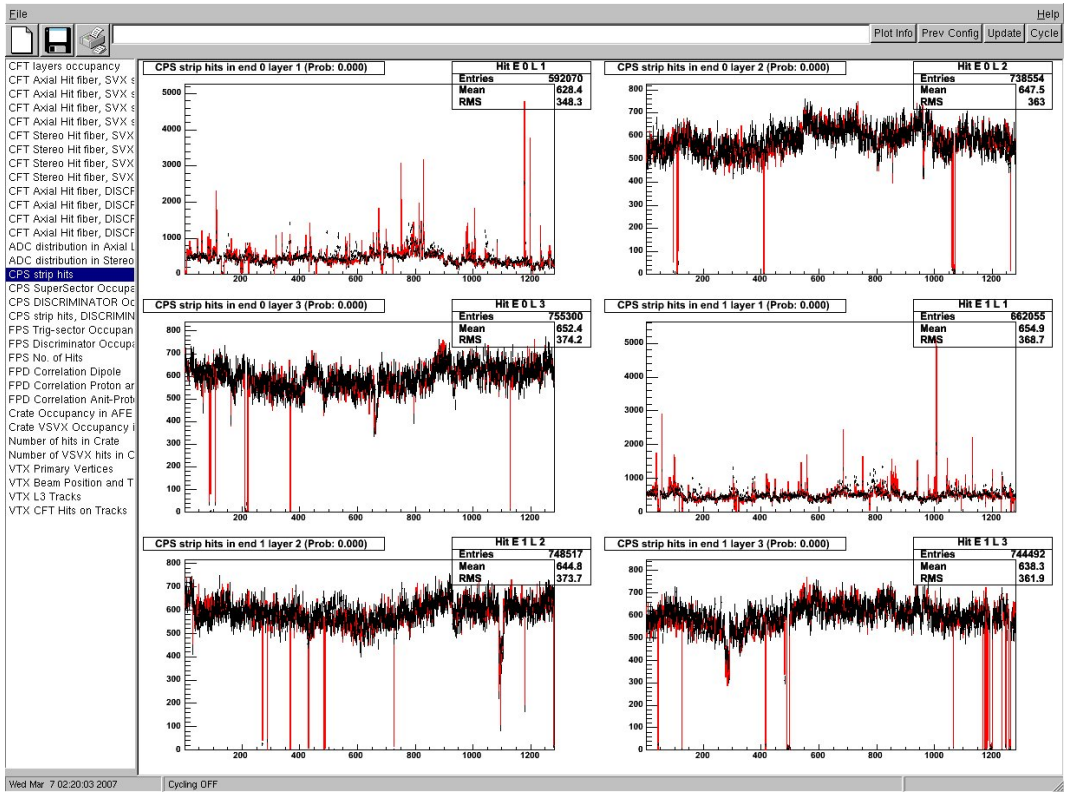




- Occupancy depends on luminosity
- Hitmaps should look reasonably flat
- Do not worry about individual hot or cold fiber
- A new hot or cold region is a real problem

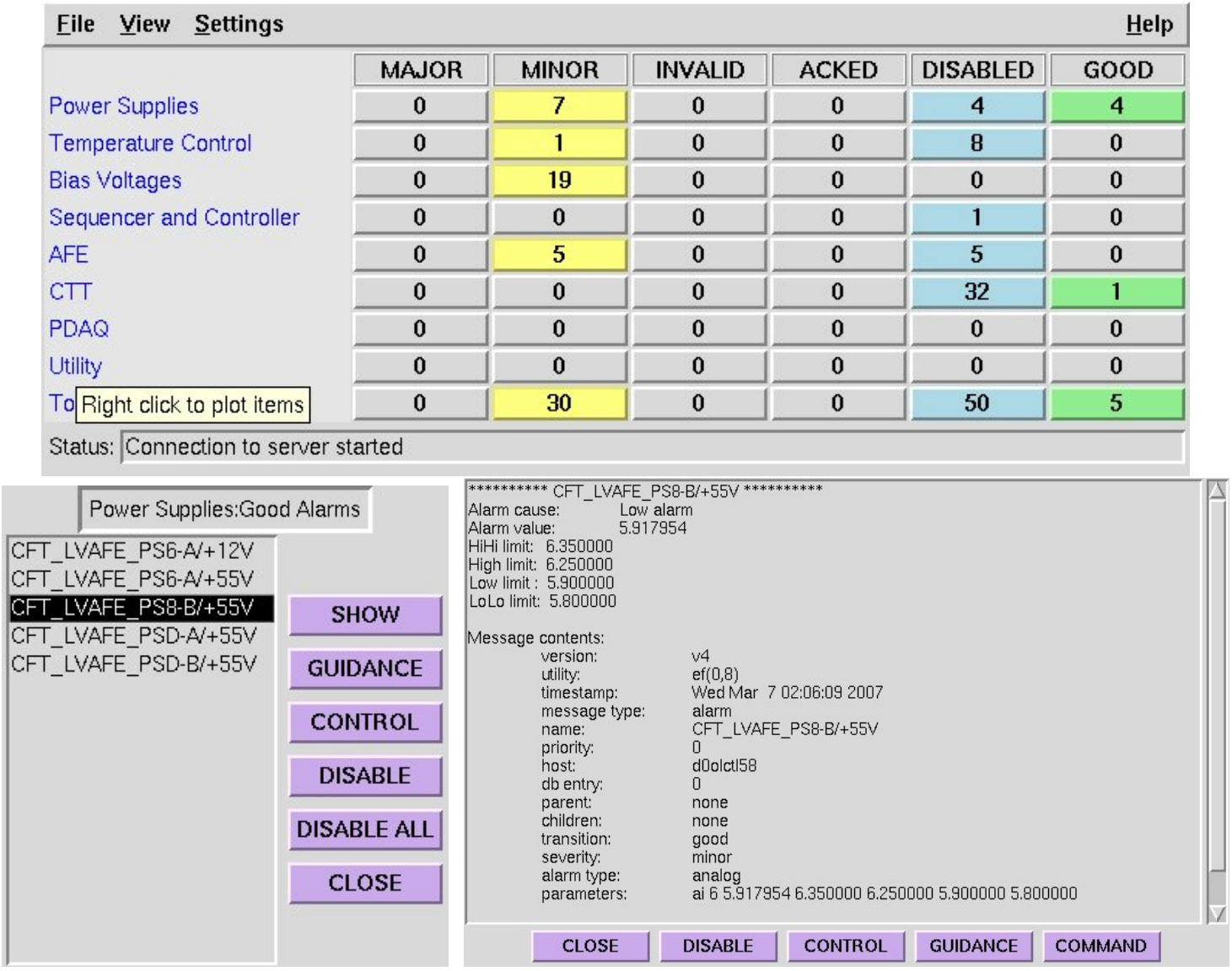
FT Examine: PS





- The same as for the CFT

CFT/CTT Alarm Display



- Document all alarms! Save their types and actual values
- Make sure all disabled alarms are known

Most Common Problems

- **Front End Busy for crates 0x50–0x53**
  - Pull out the 'CFT Trouble' checklist and follow the instructions
  - Diagnose the problem and try to solve it
  - Consult the 'Troubleshooting' section for more details
- **Temperature control alarms**
  - If few alarms persist for more than 5 min, plot cryo and call the CFT expert
  - Consult the 'Troubleshooting' section for more details
- **PDAQ alarms**
  - If the rate of alarms is high ($\sim 5\%$) make a plot and call the CFT expert
  - Consult the 'Troubleshooting' section for more details
- **Hot or cold regions in hitmaps**
  - If the deviation from the reference is significant make a plot and call the CFT expert
  - The typical numbers of hot and cold channels are in the checklist
- **Global platform power failure:** CALL EXPERTS!

General advice: Follow instructions in the checklists and on the web. Call expert when in doubt

Useful Online Resources

- **Central Fiber Tracker Homepage**: Links to updates, references, contact info
  http://www-d0online.fnal.gov/groups/cft/
  - **Shifter's checklist companion and troubleshooting**: guidance for alarm and FEB problems
    http://www-d0online.fnal.gov/groups/cft/CFT/online/ChkListTrouble.html
- **CFT shift schedule**
  http://hep.pa.msu.edu/cgi-bin/webcal/webcal.cgi?function=webmonth&cal=CFT
- **Last 24 hours of CFT/CTT e-log**: Read it before your shift
  https://www-d0online.fnal.gov/crlw/Index.jsp?inquiry=cft_ctt_24_hours

CFT/PS Shift Training: Review

- CFT & PS are important parts of the D0 detector
- Make sure all CFT crates (0x50–0x53) are in the run even during quite time and Tevatron shutdowns
- Fill out the various forms at the appropriate times during your shift, starting with the 'Beginning of Shift' checklist and ending with the 'Shift Summary'
- Watch for CFT/CTT alarms. Do not leave major alarms unaddressed
- **Document all problems!**
- Do not hesitate to call the 'on-call' expert